CLAIMS

1. A method of magnetically enhanced sputtering and plasma deposition comprising the steps of:

- providing a plasma source unit and a work piece processing unit, the plasma source unit having an inner space, the anode space, and the work piece processing unit having an inner space, the processing chamber, the anode space and the processing chamber being in direct communication with each other to provide a vacuum vessel,
- providing a vacuum in the vacuum vessel,
- providing sputtering and reactive gases into the vacuum vessel,
- providing a work piece in the processing chamber,
- providing an anode being walls of the anode space,
- providing a magnetron sputtering cathode electrically insulated from the anode, the magnetron sputtering cathode located at an end of the anode space remote from the processing chamber,
- applying periodically repeated voltage pulses between the anode and the magnetron sputtering cathode in such a manner that pulsed electric discharges are produced between the magnetron sputtering cathode and the anode, in particular between the magnetron sputtering cathode and portions of walls of discharge chamber located adjacent to the magnetron sputtering cathode,

characterized by the additional step of:

- providing a stationary magnetic mirror trap in the vacuum vessel, the trap having an axis substantially coinciding with an axis of the vacuum vessel, the magnetic mirror trap inside the process chamber guiding charged particles from the plasma outlet and past or beyond the position of the work piece and therefrom back again..

2. A method according to claim 1, **characterized in** that in providing the plasma source unit and the work piece processing unit they are separated by a partition wall having a hole.

3. A method according to claim 1, **characterized in** that a single magnetron sputtering cathode is provided.

4. A method according to claim 1, **characterized in** that in providing the stationary magnetic mirror trap, the magnetic field of the ~~trap is~~ produced mainly by two electromagnetic coils mounted outside the vacuum vessel, a first one surrounding the anode space and a second one mounted at a wall of the processing chamber opposite the end at which the magnetron sputtering cathode is mounted.

5. A method according to claim 1, **characterized by** the additional step of filtering, in the anode space, using a chemisorption filter for preventing penetration of the reactive gas into the region of the anode space adjacent to or at the magnetron sputtering cathode.

6. A method according to claim 1, **characterized in** that in applying the periodically repeated voltage pulses, the electric discharges simultaneously produce a vapor of a solid material

by sputtering material of a target included in the magnetron sputtering cathode and a partial ionization of the vapor of a solid material and the sputtering and reactive gases to provide plasmas of a solid material and gases.

7. A method according to claim 6, **characterized in** that in producing the vapor of a solid material, the vapor is deposited onto a chemisorption filter located in the anode space and used as a getter for reactive gas entering the anode space.

8. A method according to claim 6, **characterized in** that in producing the plasmas of a solid material and gases, the plasmas are made to flow along magnetic field lines from the anode space into the processing chamber.

9. A method according to claim 1, **characterized by** the additional step of providing a chemisorption filter, the filter comprising layers of a solid material obtained from a vapor of solid material, produced by the discharges, condensed onto walls of the anode space, the layers acting as a getter for the reactive gas/gases, in particular areas of the layers located on portions of walls of the anode space located remotely or at distance from the magnetron sputtering cathode.

10. A method according to claim 9, **characterized in** that in providing the chemisorption filter, the chemisorption filter is made to include layers of the solid material obtained from the vapor of solid material, produced by the discharges, condensed onto surfaces of filter parts located inside the anode space.

11. A method according to claim 1, **characterized in** that in providing the magnetron sputtering cathode, it is made to have a planar circular geometry including a moving magnet having dimensions smaller than those of the magnetron sputtering cathode, the moving magnet rotating or reciprocally moving in a direction parallel to long sides of the magnetron sputtering cathode.

12. A method according to claim 1, **characterized in** that in providing the magnetic mirror trap, it is provided by arranging one work piece processing unit and two plasma sources located at the same axis, the processing chamber and the anode spaces of the two plasma sources forming the vacuum vessel.

13. A method according to claim 1, **characterized in** that in providing the mirror magnetic trap, it is provided having a cusped magnetic field produced by four plasma sources, each plasma source including a chemisorption filter.

14. A device for reactive magnetron sputtering comprising:

- a plasma source for generating a plasma and having a plasma outlet,
- a process chamber connected to the plasma source at the plasma outlet for receiving plasma, the process chamber arranged to contain a work piece to be coated with material,

characterized by a work piece magnet assembly located at a remote end of the process chamber, behind the position of a work piece, seen from the plasma outlet, for generating a magnetic field

which acts as a magnetic mirror trap and inside the process chamber guides charged particles from the plasma outlet and past or beyond the position of the work piece and therefrom back again.

15. A device according to claim 14, **characterized in** that the plasma source includes:

- a pulsed power supply for applying voltage pulses between an anode and a cathode to make discharges between the anode and cathode producing electrons,
- the cathode comprising a metal target from which metal material is to be sputtered,
- a cathode magnet assembly for providing a magnetron magnetic field having a magnetron configuration at a surface of the target for trapping electrons in the magnetron magnetic field,
- a discharge chamber containing the target and having sidewalls connected as the anode,
- a discharge chamber magnet assembly for generating a discharge chamber magnetic field guiding charged particles away from the cathode to produce a plasma flow to the plasma outlet.

16. A device according to claim 14, **characterized by** inlets for a sputtering gas and a reactive or processing gas to be ionized and an outlet connected to a vacuum pump.

17. A device according to claim 14, **characterized in** that the inlets for a sputtering gas and for a reactive or processing gas are connected to the process chamber.

18. A device according to claim 14, **characterized by** sorption filter plates located in the discharge chamber and electrically connected to the anode.

19. A device according to claim 18, **characterized in** that the sorption filter plates have cylindrical shapes and are located in such a way that axes of the cylinder shapes coincide with an axis of the anode and the cylinder shapes are similar to the shape of the cathode or the sorption filter plates include two sets of flat sorption filter plates crossing each other.

20. A device according to claim 18, **characterized in** that the sorption filter plates have surfaces substantially parallel to the magnetic field or to an axis of the device.

21. A device according to claim 14, **characterized in** that the work piece magnet assembly is part of another plasma source similar to the first one, connected by its plasma outlet to the process chamber at said remote end.

22. A device according to claim 14, **characterized by** a work piece holder for the work piece, the work piece holder arranged to move the ~~work~~ piece in the process chamber.

23. A device for reactive magnetron sputtering comprising

- a plasma source for generating a plasma flow and having an anode, a cathode and a plasma outlet for the plasma flow,
- a process chamber connected to the plasma source at the plasma outlet for receiving plasma, the process chamber arranged to contain a work piece to be coated with material,

characterized in that the plasma source includes filter plates having getter/sorption surfaces for gettering/adsorbing reactive gas ions flowing towards the cathode and neutral particles sputtered from the cathode, the filter plates placed between the cathode and the plasma outlet.

24. A device according to claim 23, **characterized in** that the sorption filter plates have cylindrical shapes and are located in such a way that axes of the cylinder shapes coincide with an axis of the anode and the cylinder shapes are similar to the shape of the cathode or the sorption filter plates include two sets of flat sorption filter plates crossing each other.

25. A device for reactive magnetron sputtering comprising

- a plasma source for generating a plasma flow,
- a process chamber connected to the plasma source at the plasma outlet for receiving plasma, the process chamber arranged to contain a work piece to be coated with material,

characterized in that the inlets for a sputtering gas and for a reactive or processing gas to be ionized both are connected directly to the process chamber.